

# SOLOMON BASIN TOTAL MAXIMUM DAILY LOAD

**Waterbody/Assessment Unit (AU): Salt Creek (Minneapolis) -  
Upper Solomon River - Lower Solomon River**

**Water Quality Impairment: Chloride**

## 1. INTRODUCTION AND PROBLEM IDENTIFICATION

**Subbasin:** Solomon River

**County:** Cloud, Dickinson, Jewell, Lincoln,  
Ottawa, Mitchell, Saline and Smith

**HUC 8:** 10260015

**HUC 11 (HUC 14s):**     **010** (090)  
(see **Figure 1**)       **020** (030, 040, 050, 060 and 070)  
                             **030** (010, 020, 030, 040, 050, 060, 070 and 080)  
                             **040** (010, 020, 030, 040, 050 and 060)  
                             **050** (010, 020, 030, 040 and 050)  
                             **060** (010, 060, 070 and 080)  
                             **070** (010, 020, 030, 040 and 050)

**Drainage Area:**       1,349.2 square miles

**Main Stem Segment:**   WQLS: Lower Solomon River AU; 1, 3, 5, 6, 8 and 12 in part  
(Solomon River) starting at confluence with the Smoky Hill River on  
the west side of Dickinson County and traveling upstream to  
downstream boundary of HUC14 10260015030050 in southwest  
Cloud County (**Figure 2**).

WQLS: Salt Creek (Minneapolis) AU; 27, 29 and 30 (Salt Creek)  
starting and confluence with the Solomon River in south-central  
Ottawa County and traveling upstream to headwaters in southwest  
Mitchell County (**Figure 2**).

WQLS: Upper Solomon River AU; 12 in part, 14,16 and 23 (Solomon  
River) starting at downstream boundary of HUC14 10260015030050  
in southwest Cloud County and traveling upstream to Waconda Lake  
in northwest Mitchell County (**Figure 2**).

### **Tributaries:**

**Lower Solomon R. AU**   Coal Creek (2)  
(see **Figure 1**)       Sand Creek (4)  
                             Antelope Creek (58)  
                             Battle Creek (57)  
                             Lindsey Creek (7)  
                             Dry Creek (52)

Yockey Creek (50)  
Mortimer Creek (49)  
Cris Creek (48)

**Salt Cr.**  
**(Minneapolis) AU**  
(see **Figure 1**)

Lost Creek (56)  
First Creek (28)  
    Spring Creek (53)  
Second Creek (53)  
W. Elkhorn Creek (47)  
Rattlesnake Creek (31 and 32)  
    Battle Creek (33)  
Fifth Creek (45)  
Little Creek (44)  
Antelope Creek (43)

**Upper Solomon R. AU**  
(see **Figure 1**)

Second Creek (51)  
Fourth Creek (46)  
Marshall Creek (42)  
Plum Creek (13)  
    Dry Creek (37)  
Leban Creek (41)  
Mulberry Creek (36)  
Indian Creek (40)  
Turkey Creek (39)  
Frog Creek (34)

**Designated Uses:**

**Lower Solomon R. AU** Expected Aquatic Life Support, Primary Contact Recreation, Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments (Solomon River segments 1, 3, 5, 6, 8, 12)

**Salt Cr.**  
**(Minneapolis) AU**

Expected Aquatic Life Support, Primary Contact Recreation, Food Procurement Use for Main Stem Segments (Salt Creek segments 27, 29, 30)

**Upper Solomon R. AU** Expected Aquatic Life Support, Primary Contact Recreation, Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments (Solomon River segments 12, 14, 16, 23).

**Impaired Use:** Domestic Water Supply (Potentially)

**Water Quality Standard:** Domestic Water Supply: 250 mg/L at any point of domestic water supply diversion (K.A.R.28-16-28e(c) (3) (A).

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water quality criteria listed in Table 1a of subsection (d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply shall be the background concentration, as defined in KAR 28-16-28b(e). Background concentrations shall be established using the methods outlined in the “Kansas implementation procedures: surface water quality standards,” as defined in KAR 28-16-28b(ee).. (KAR 28-16-28e(c)(3)(B)).

860 mg/l for Aquatic Life Support [Acute criterion] (KAR 28-16-28e(c)(2)(F)(ii))

In surface waters designated for the groundwater recharge use, water quality shall be such that, at a minimum, degradation of groundwater quality does not occur. Degradation shall include any statistically significant increase in the concentration of any chemical or radiological contaminant...in groundwater resulting from surface water infiltration or injection. (KAR 28-16-28e(c)(6)).

## **2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT**

**Level of Support for Designated Use under 2002 303(d):** Not Supporting Domestic Water Supply Use.

**Monitoring Sites:** Station 266 at Niles (Lower Solomon River); Station 512 near Minneapolis (Salt Creek); Station 511 near Glasco (Upper Solomon River).

**Period of Record Used:** 1990 – 2001 for Stations 266, 511 and 512 (**Figures 3, 4, and 5**, respectively)

**Flow Record:** Lower Solomon R.: Solomon River at Niles (USGS Station 06876900; 1970 - 2002)

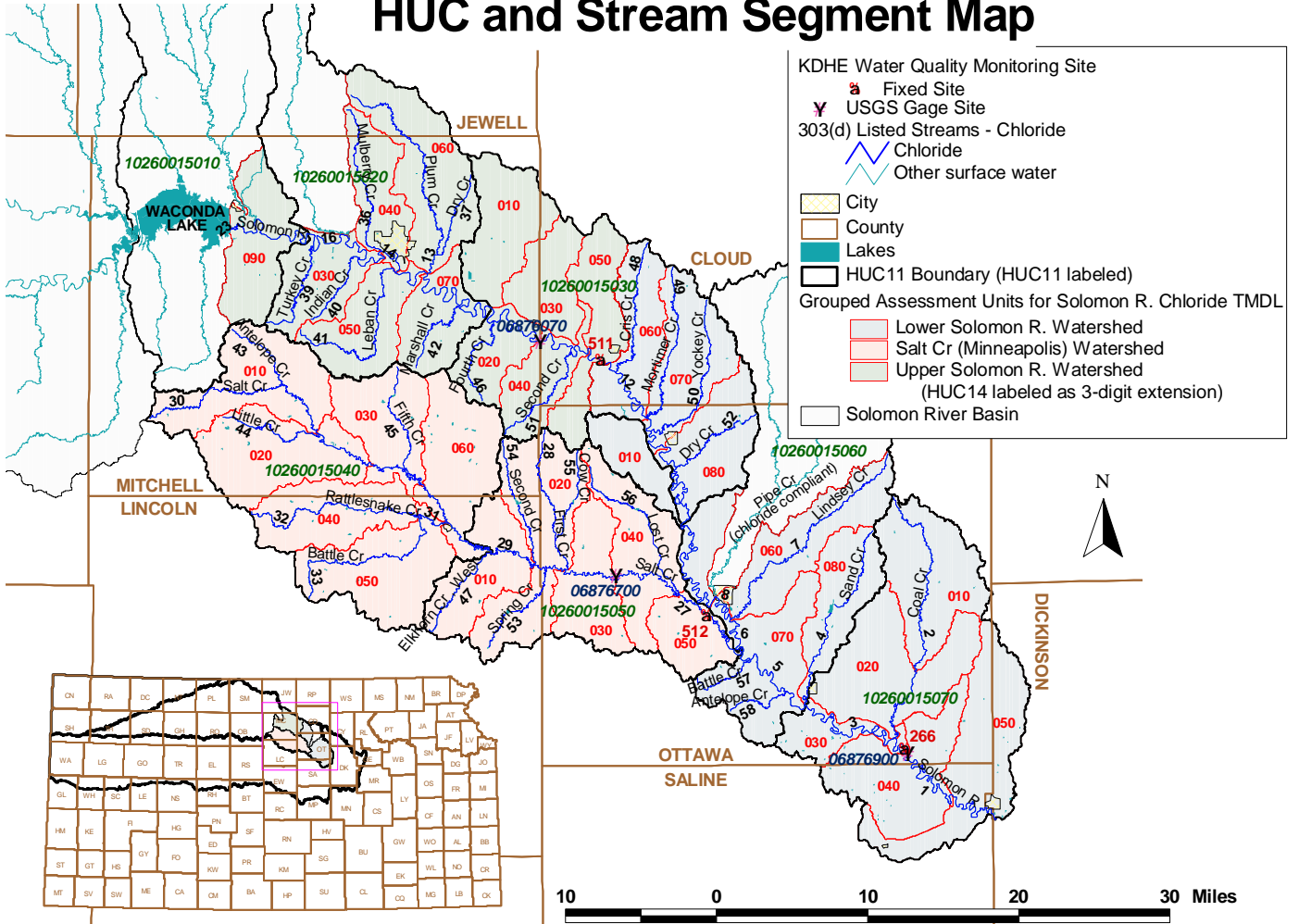
Salt Creek: Salt Creek near Ada (USGS Station 06876700; 1970 – 2002);

Upper Solomon R.: Solomon River near Simpson (USGS Station 06876070; 1990 – 2002)

### **Long Term Flow Conditions:**

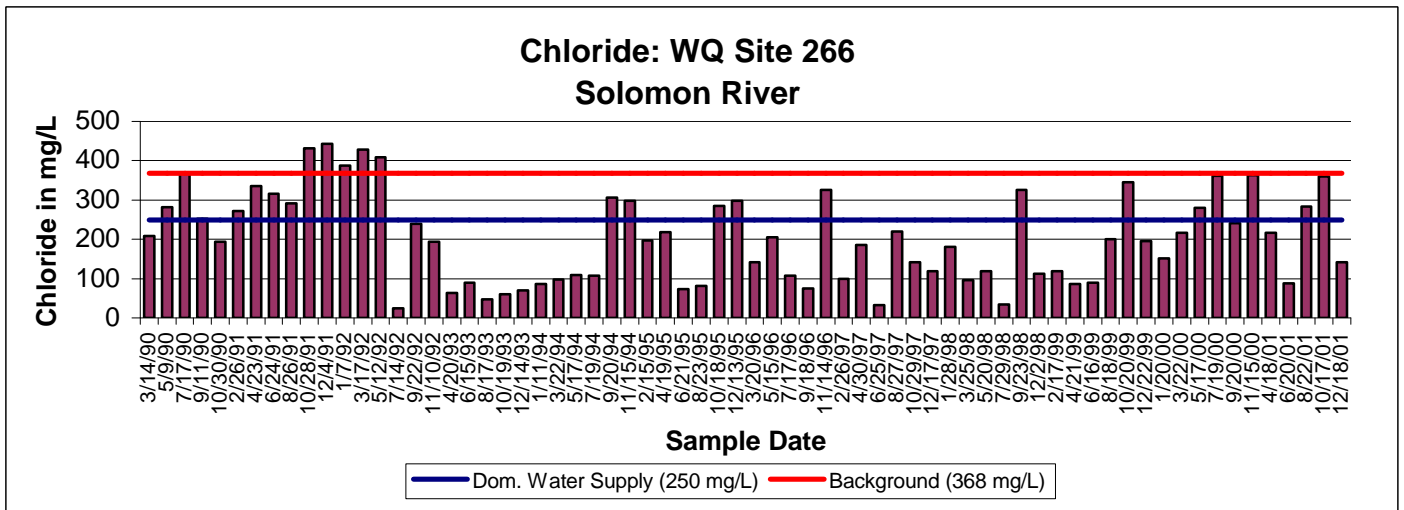
Median Flows:               Solomon River at Niles = 170 cfs  
                                     Salt Creek = 15.3 cfs  
                                     Solomon River at Simpson =138 cfs

# Solomon River Chloride TMDL HUC and Stream Segment Map

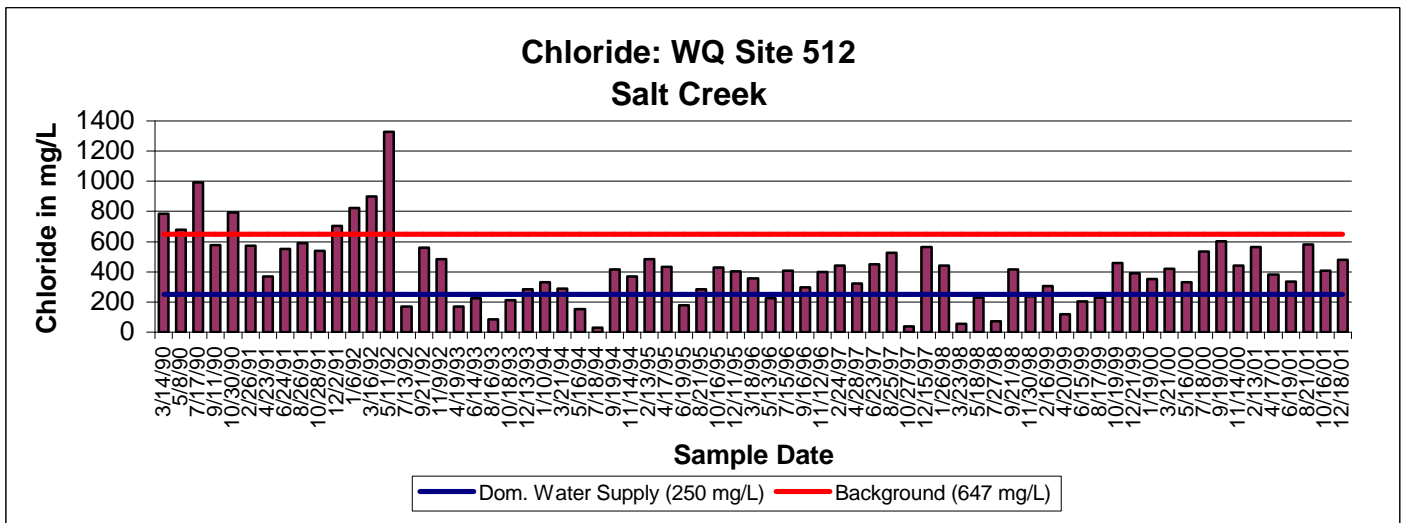


### Figure 1

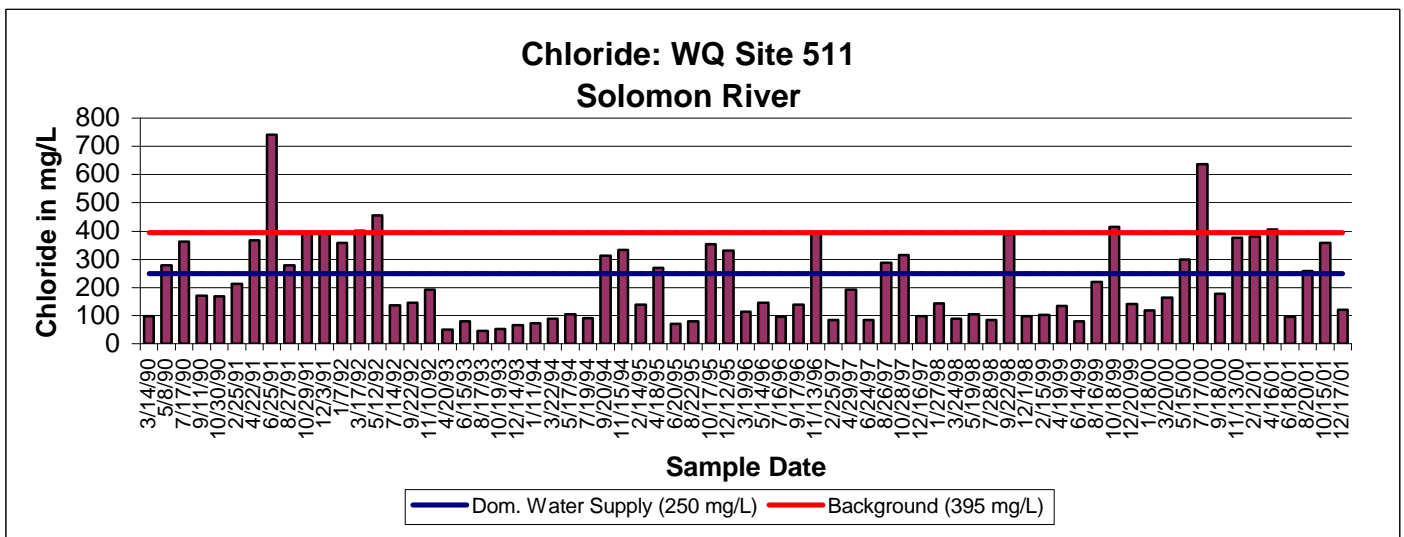
(The Pipe Creek watershed was not impaired by chloride. Pipe Creek's average chloride concentration was 23 mg/L)



**Figure 2**



**Figure 3**



**Figure 4**

**Current Conditions:** Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for each sampling site were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for the Domestic Water Supply criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of tons per day. These load curves represent the TMDL since any point along the curve denotes water quality for the standard at that flow. Historic excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration curve (**Figure 15, 16 and 17**).

Site 266: Excursions were seen in each of the three defined seasons and are outlined in **Table 1**. Twenty-nine percent of the Spring samples and 47% of Summer-Fall samples were over the domestic water supply criterion. Thirty-two percent of the Winter samples were over the domestic supply criterion. Overall, 35% of the samples were over the domestic water criteria. This would represent a baseline condition of non-support of the impaired designated use.

**Table 1**

NUMBER OF SAMPLES OVER CHLORIDE STANDARD OF 250 mg/L BY FLOW								
Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq.
Solomon River at Niles (266)	Spring	0	0	0	2	2	3	7/24 = 29%
	Summer/Fall	0	0	2	5	0	2	9/19 = 47%
	Winter	0	0	1	3	1	3	8/25 = 32%

Site 512: Excursions were seen in each of the three defined seasons and are outlined in **Table 2**. Fifty-four percent of the Spring samples and 79% of Summer-Fall samples were over the domestic water supply criterion. Ninety-two percent of the Winter samples were over the domestic supply criterion. Overall, 75% of the samples were over the domestic water criteria. This would represent a baseline condition of non-support of the impaired designated use.

**Table 2**

NUMBER OF SAMPLES OVER CHLORIDE STANDARD OF 250 mg/L BY FLOW								
Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq.
Salt Creek near Minneapolis (512)	Spring	0	0	5	3	4	1	13/24 = 54%
	Summer/Fall	0	0	2	6	2	5	15/19 = 79%
	Winter	0	3	10	6	4	1	24/26 = 92%

Site 511: Excursions were seen in each of the three defined seasons and are outlined in **Table 3**. Thirty-eight percent of the Spring samples and 53% of Summer-Fall samples were over the domestic water supply criterion. Thirty-one percent of the Winter samples were over the domestic supply criterion. Overall, 39% of the samples were over the domestic water criteria. This would represent a baseline condition of non-support of the impaired designated use.

Table 3

NUMBER OF SAMPLES OVER CHLORIDE STANDARD OF 250 mg/L BY FLOW								
Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq.
Solomon River near Simpson (511)	Spring	0	0	0	3	4	2	9/24 = 38%
	Summer/Fall	0	0	0	5	4	1	10/19 = 53%
	Winter	0	0	0	2	3	3	8/26 = 31%

### **Desired Endpoints of Water Quality (Implied Load Capacity) at Sites 266, 512 and 511 over 2008 – 2012**

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use. This TMDL will, however, be phased. The current standard of 250 mg/L of chloride was used to establish the TMDL. However, the Solomon River system is subject to loading of chloride that intrudes from the Dakota aquifer into the overlying alluvial aquifer along the river valley and then from the alluvial aquifer into the Solomon River. As such, the watershed's main stem and many of its tributaries have elevated chloride levels from this natural source. This natural background of chloride, consistently above 250 mg/L, makes achievement of the Standard impossible for stream flow conditions less than median flow at Sites 266, 512 and 511. At Sites 266, 511 and 512, since the Standard is not achievable because of natural contributions to the chloride load, an alternative endpoint is needed. There is a point of diversion for potable water present on the Solomon River (Segment 14, City of Beloit) to activate the domestic water criteria on this segment and an endpoint of 250 mg/L chloride is established on this segment at the point of diversion because of this. The mechanisms to achieve domestic water criteria on segment 14 will be discussed within Sections 3 (Source Inventory and Assessment) and 5 (Implementation) of this TMDL. Most water use in the Solomon Basin is surface water irrigation.

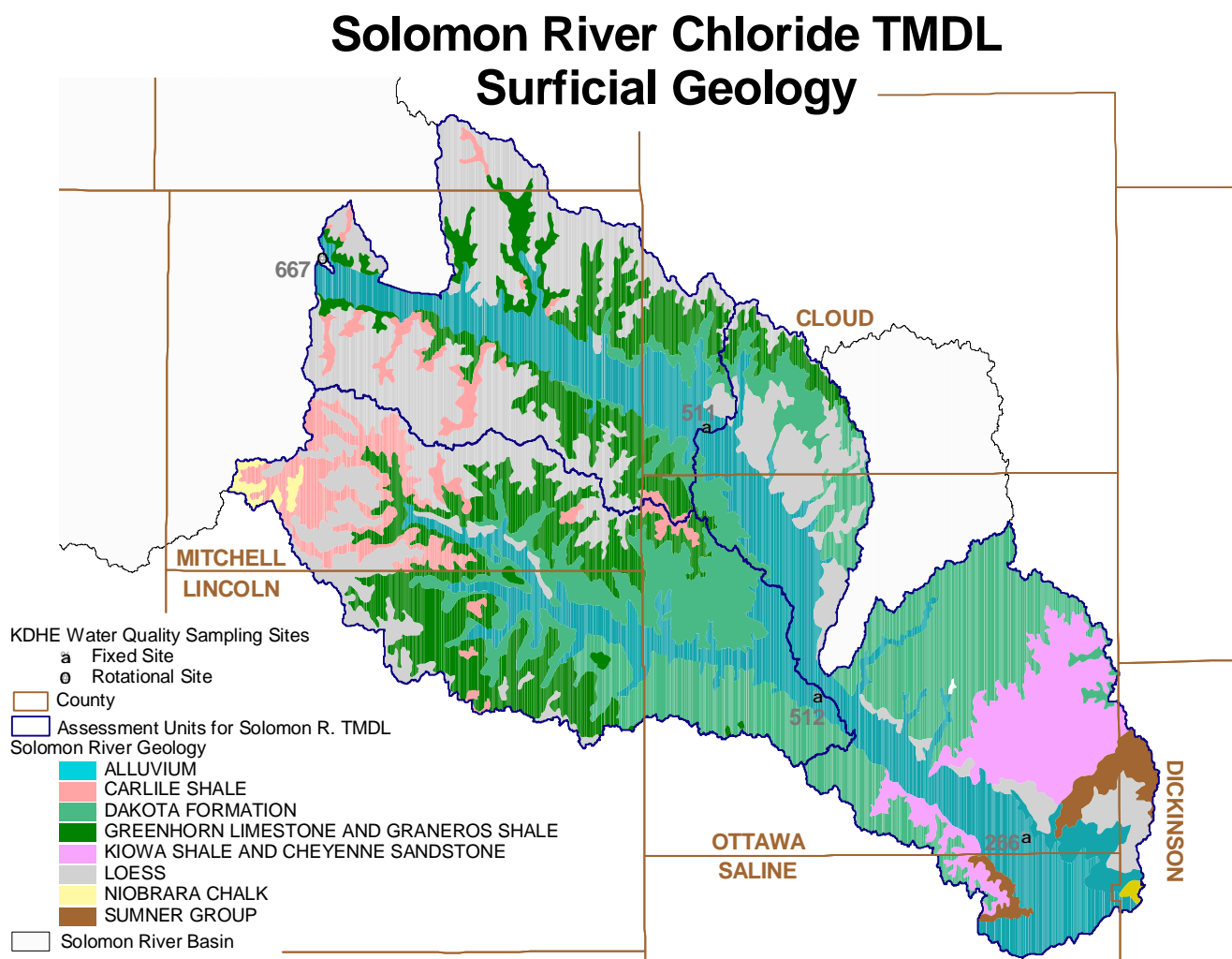
Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established from flows less than median in-stream flow. The specific stream criteria to supplant the general standard will be developed concurrent with Phase One of this TMDL following the appropriate administrative and technical Water Quality Standards processes. Meanwhile, a tentative endpoint has been developed from currently available information at water quality monitoring sites 266, 511 and 512. The 80<sup>th</sup> percentile of chloride concentrations at Site 266 for flows less than the median flow is 370 mg/L and sets the tentative endpoint for this site. The 80<sup>th</sup> percentile of chloride concentrations at Site 512 is 650 mg/L and for Site 511 is 400 mg/L for flows less than the median flow and sets the tentative endpoint for this Site. The Phase Two TMDL will be based on the future standard applied to these flows within the contributing portions of the Solomon River watershed to Sites 266, 512 and 511. These endpoints are to be achieved only upon initiation of use of these impaired streams segments for potable consumption, through a constructed point of diversion.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated chloride levels. Achievement of the endpoints indicate loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

### 3. SOURCE INVENTORY AND ASSESSMENT

(Background and Historical Assessment based upon analysis provided by Don Whittemore, Kansas Geologic Survey and KGS Open-File Report 2003-49 also by Whittemore)

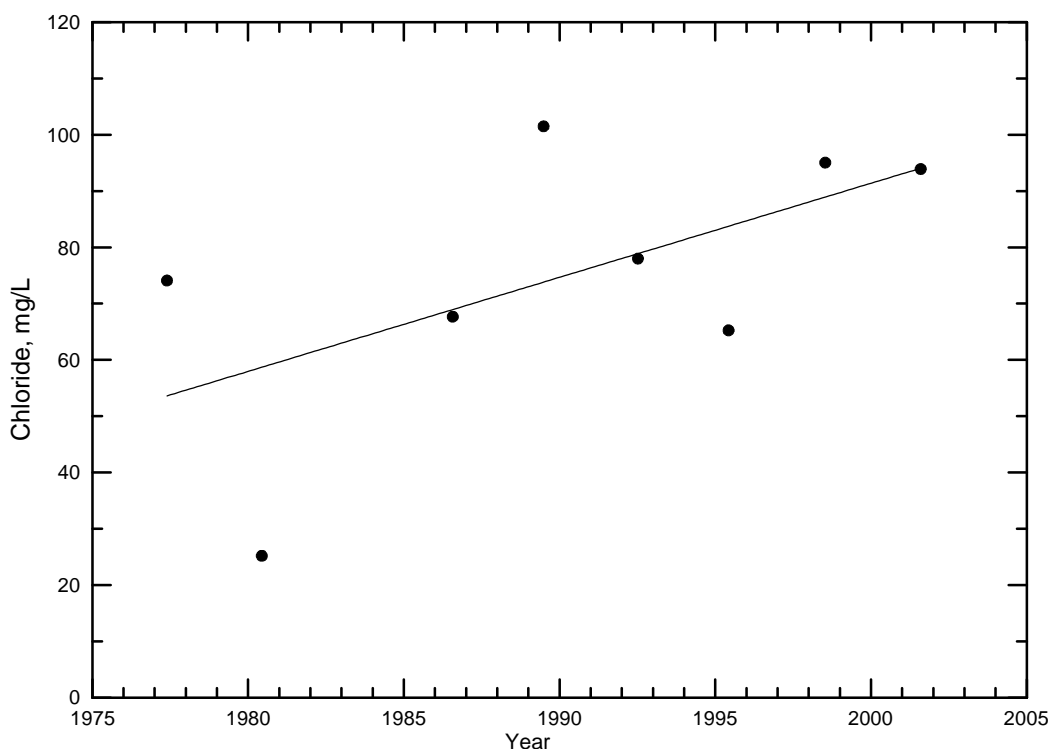
**Chloride background assessment:** The main source of high chloride in the Solomon River near Glasco (Site 511), the Solomon River at Niles (Site 266), and Salt Creek near Minneapolis (Site 266) is the discharge of naturally saline ground water from the Dakota aquifer into the overlying alluvial aquifer and thence into the river and creek. The key stretch of the Solomon River where saline ground water from the Dakota aquifer intrudes is between Glen Elder Dam of Waconda Lake and Glasco (Site 511) (**Figure 5**). The primary area where saline water discharges from the Dakota aquifer into the Salt Creek watershed is upstream of the Ottawa-Lincoln county line in southeastern Mitchell County and north-central Lincoln County. The chloride content of saline groundwater in the upper Dakota aquifer exceeds 1,000 mg/L in most of Mitchell County and a small part of north-central Lincoln County. Natural weathering of upper Cretaceous bedrock contributes a substantial portion of the dissolved chloride in the Solomon River near Glasco (Site 511) and at Niles (Site 266) at chloride concentrations below 200 mg/L and at higher flows.



**Figure 5**

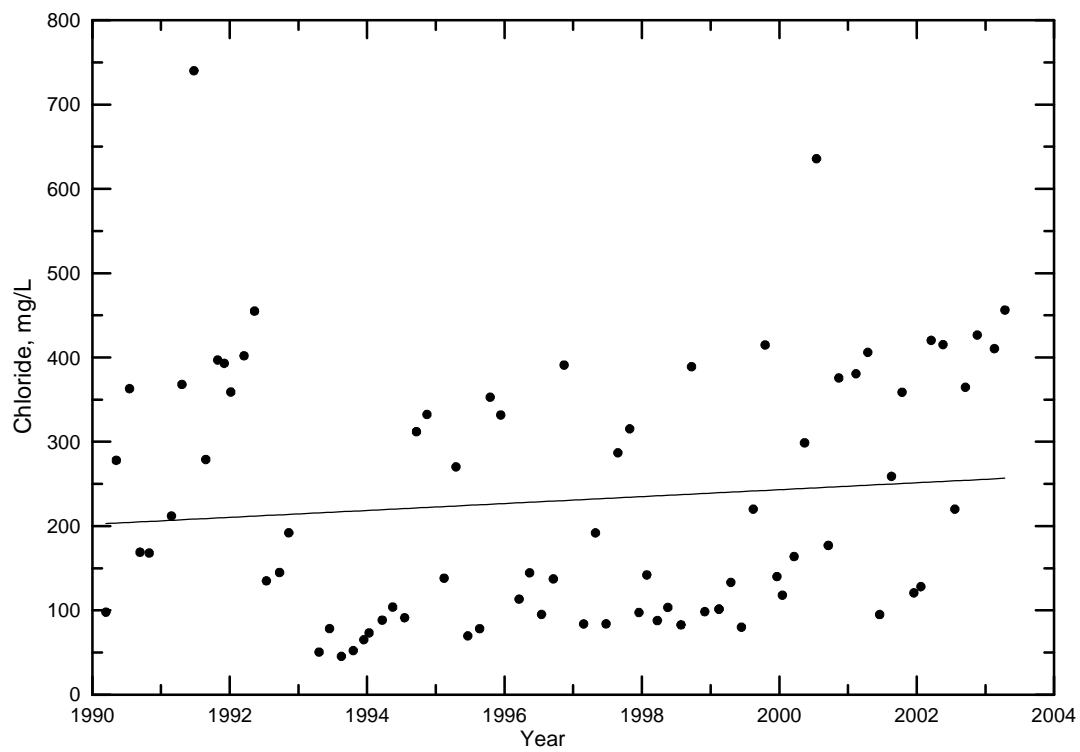


Waconda Lake is located immediately upstream of the Upper Solomon River watershed. The mean and median chloride contents of Waconda Lake during 1977-2001 were 75 and 76 mg/L, respectively. The data used for the determination of the mean and median are the averages of measurements at different sites at the lake for a particular date. The linear regression of chloride concentrations for Waconda Lake (**Figure 6**) suggests an increase with time. However, the correlation between chloride and time is not statistically significant due to the large variation in the values for the limited number of observations. Additional sampling of the lake over time will be necessary to determine the significance of this increase. The increase is consistent with the rises in chloride concentrations (both of which are statistically significant) from the 1960s to the early 2000s in the North and South forks Solomon River (See related TMDLs on those watersheds). Based on the lake data, the estimated range in chloride concentrations that could usually be expected in outflows from Waconda Lake are 60-110 mg/L.

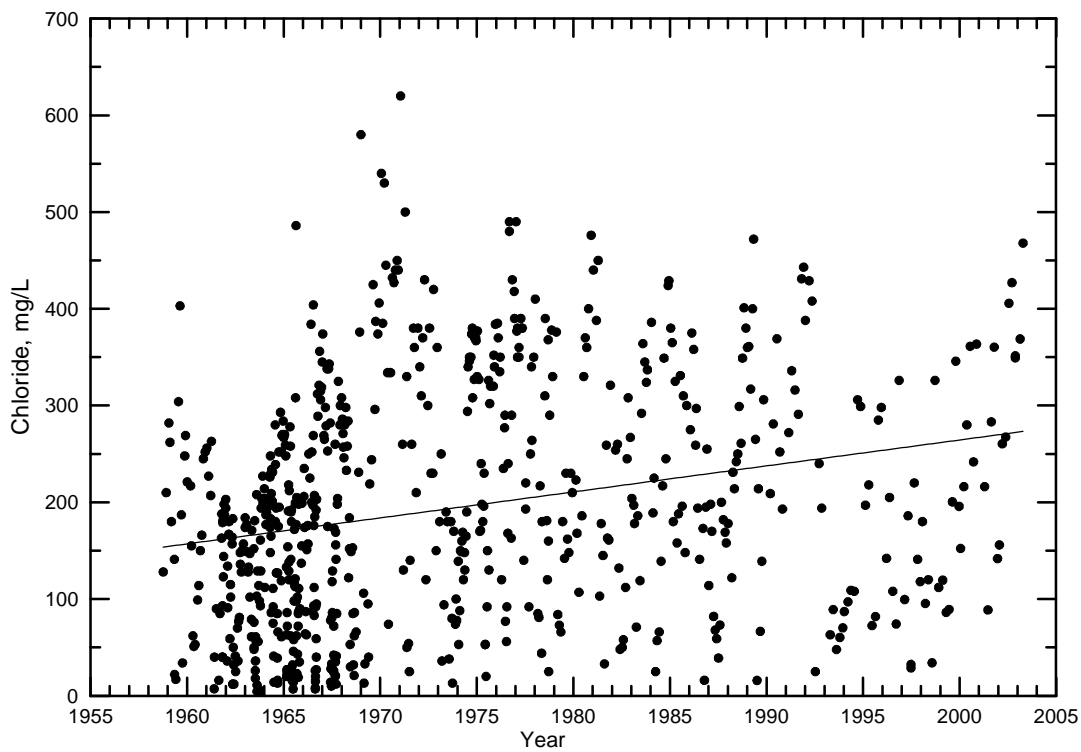


**Figure 6** (Waconda Lake; line is linear regression)

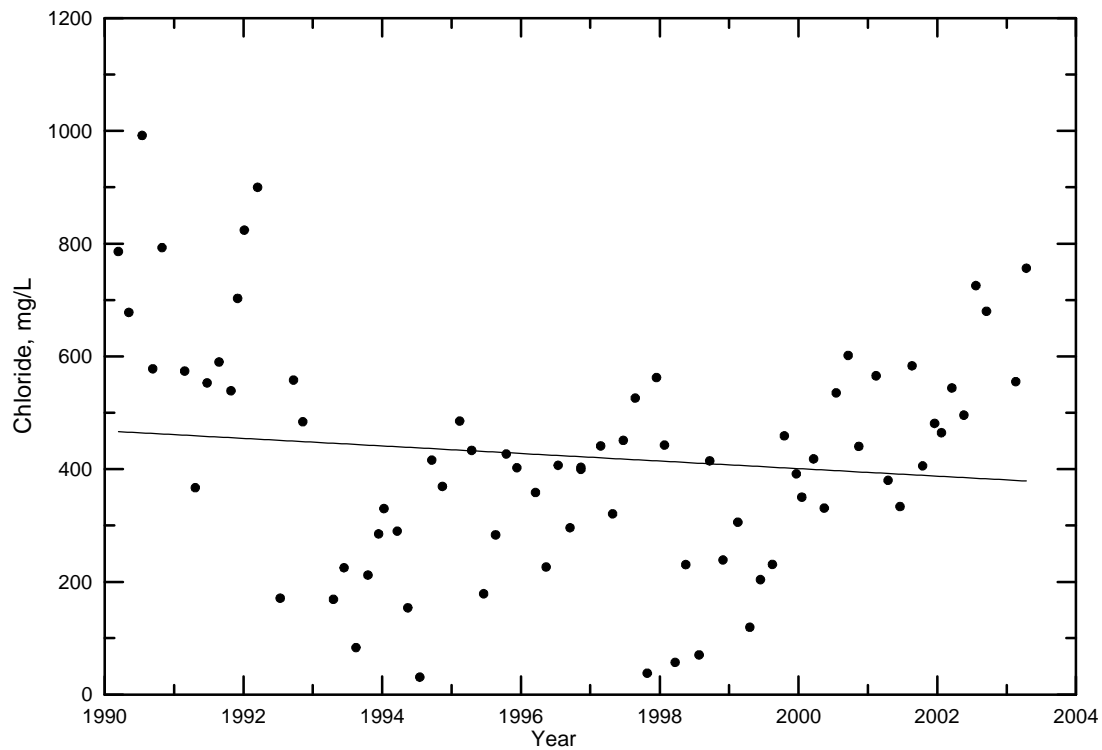
**Natural factors controlling variations in chloride:** The chloride concentration is highly variable in the Solomon River near Glasco (Site 511) and at Niles (Site 266 – includes USGS data) and in Salt Creek near Minneapolis (Site 512) (**Figures 7 - 9**, respectively). Large fluctuations in the amount of rainfall that runs off into the Solomon River and Salt Creek (which dilutes the more mineralized baseflow) is the main cause of the variation seen in Figures 7 - 9.



**Figure 7** (Site 511; line is linear regression)

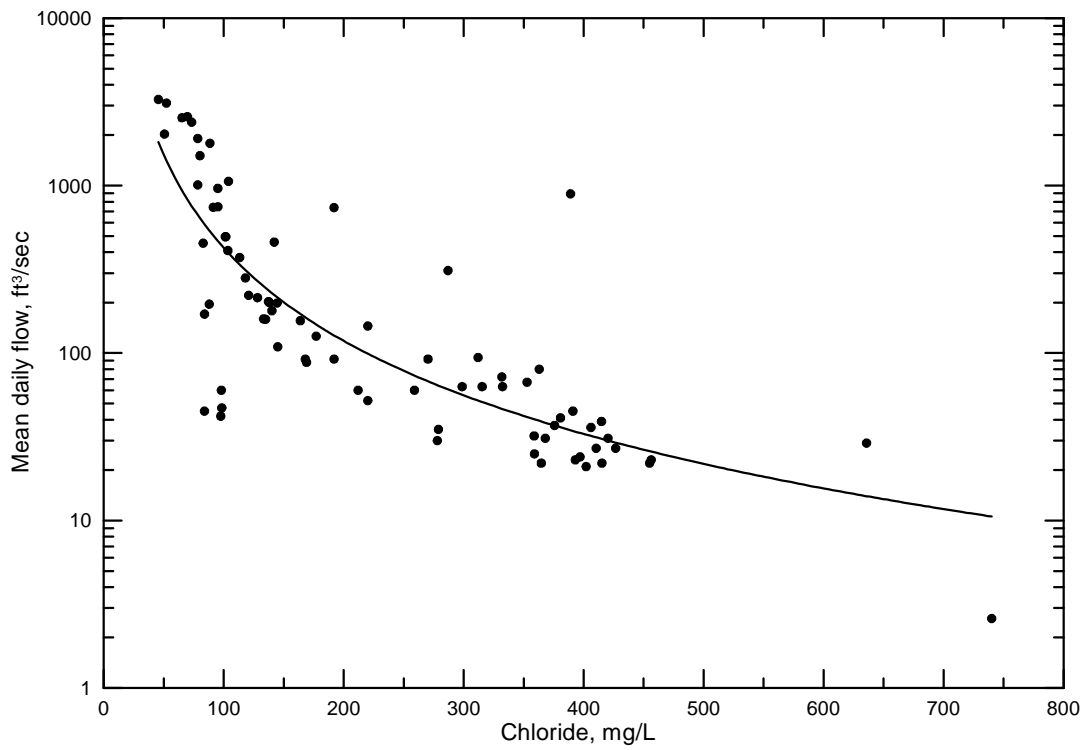


**Figure 8** (Site 266; line is linear regression)

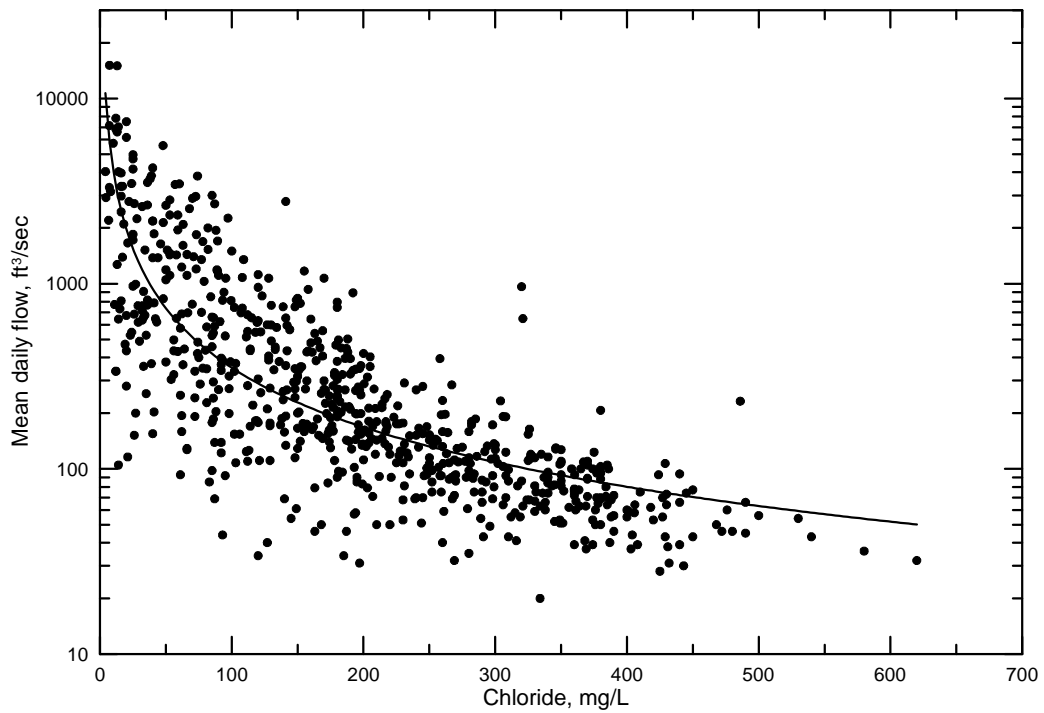


**Figure 9** (Site 512; line is linear regression)

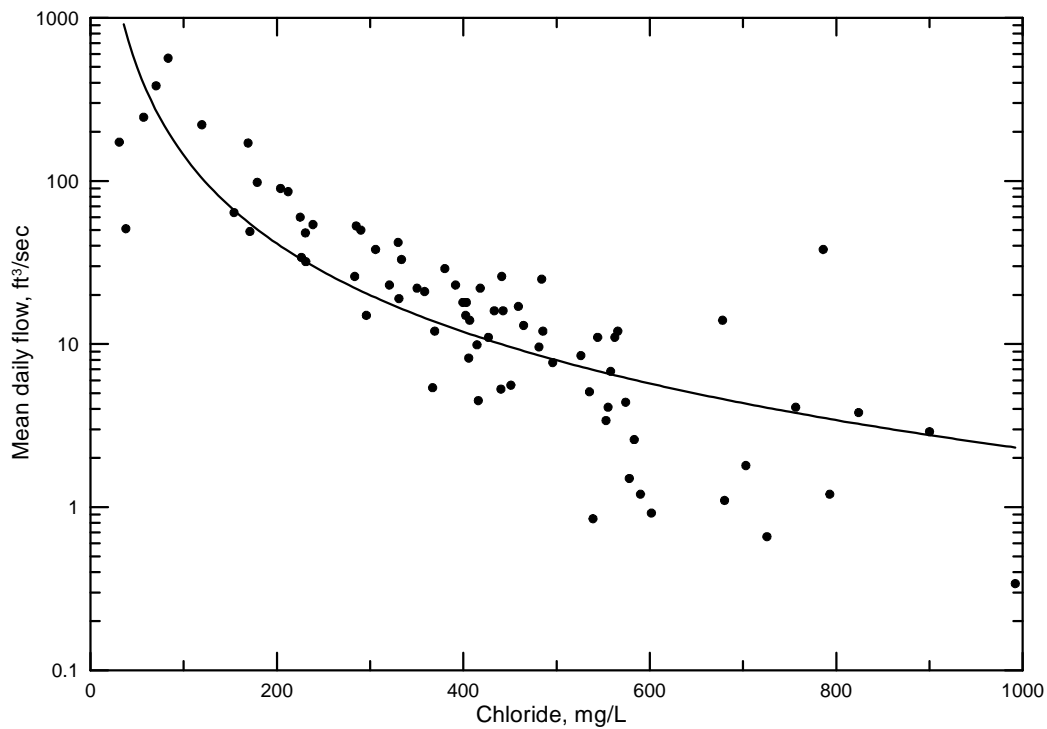
The general inverse relationship between flow in the Upper and Lower Solomon River and Salt Creek watersheds and the chloride content (**Figures 10-12**) illustrates that the higher flows are generally lower in chloride content and represent the influence of runoff. The influence of saline ground-water intrusion from the underlying Dakota aquifer becomes greater at lower flows. Changes in the amount of water released from Waconda Lake increases the amount of variation in the flow and chloride content of the Solomon River (Sites 511 and Site 266, which includes USGS data) and, thus, increases the scatter about the best-fit power curve in **Figures 10** and **11**. The scatter about the best-fit curve in the flow versus chloride plot for Salt Creek (**Figure 12**) is less than that for the lower Solomon River mainly because there is no lake release to add to the flow and vary the chloride concentration.



**Figure 10 (Site 511)**



**Figure 11 (Site 266)**



**Figure 12 (Site 512)**

**Water Use:** Most water use from the Upper Solomon River watershed (between Waconda Lake and Site 511) is for surface water irrigation, supplied predominately by releases from Waconda Lake. Total reported water use in 2001 was 21,941 acre-feet of which 19,750 acre-feet was for irrigation from surface water and 1,243 acre-feet was from groundwater. A total of 14,696 acres were irrigated. Therefore, surface water irrigation development in the Upper Solomon River watershed is significant (**Figures 13 and 14**).

Total water use in 2001 for the Lower Solomon River watershed was 3,643 acre-feet of which 109 acre-feet was from surface water sources and 1,971 was from groundwater sources. A total of 3,069 acres were irrigated.

In contrast, the Salt Creek (Minneapolis) watershed's total use was 591 acre-feet in 2001. Fifty-two acre-feet was used for irrigation from surface water sources and 523 acre-feet from groundwater sources. Only 828 acres were irrigated in the Salt Creek (Minneapolis) watershed.

# Solomon River Chloride TMDL Points of Diversion - Source

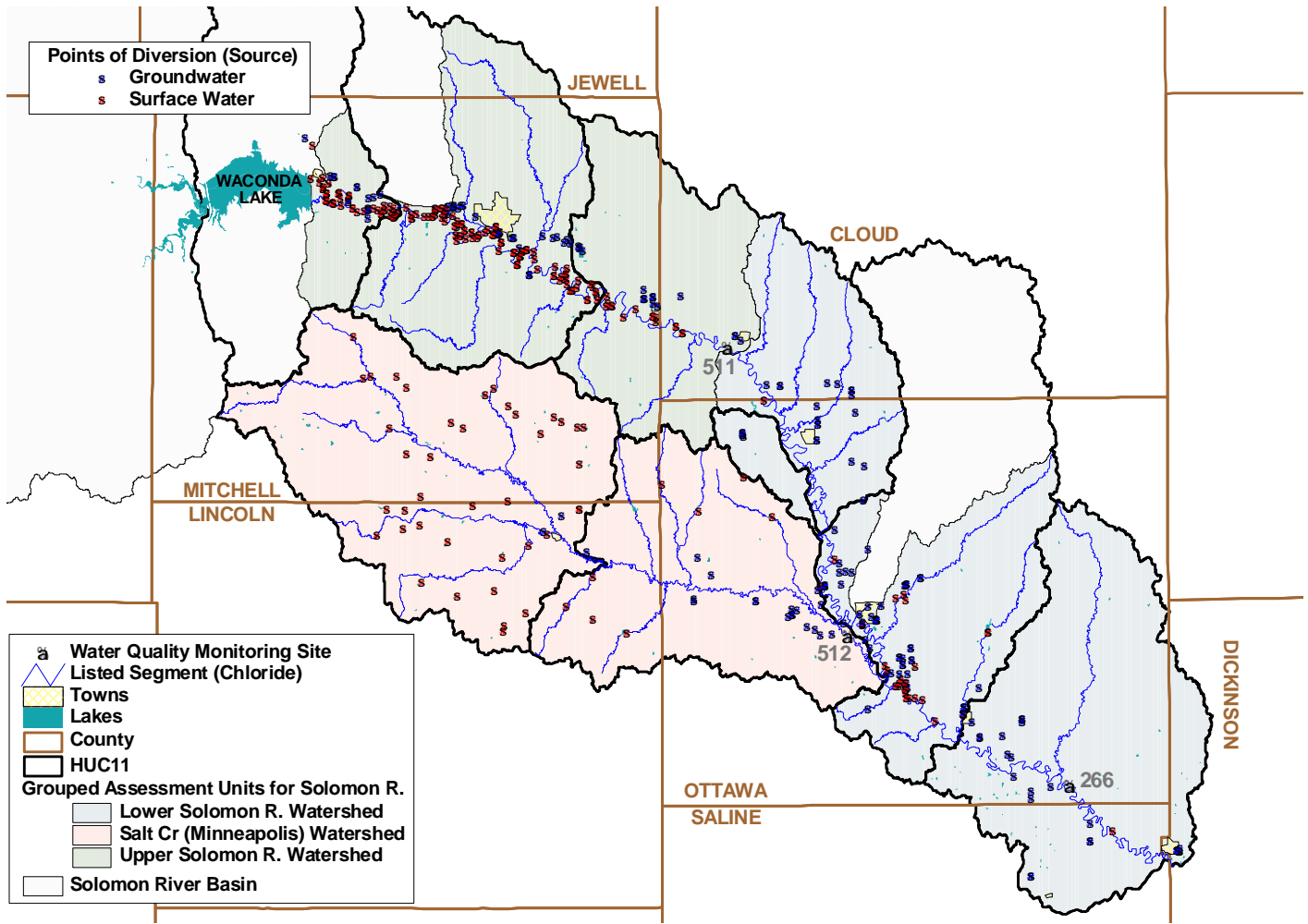


Figure 13

# Solomon River Chloride TMDL

## Points of Diversion - Use Made of Water

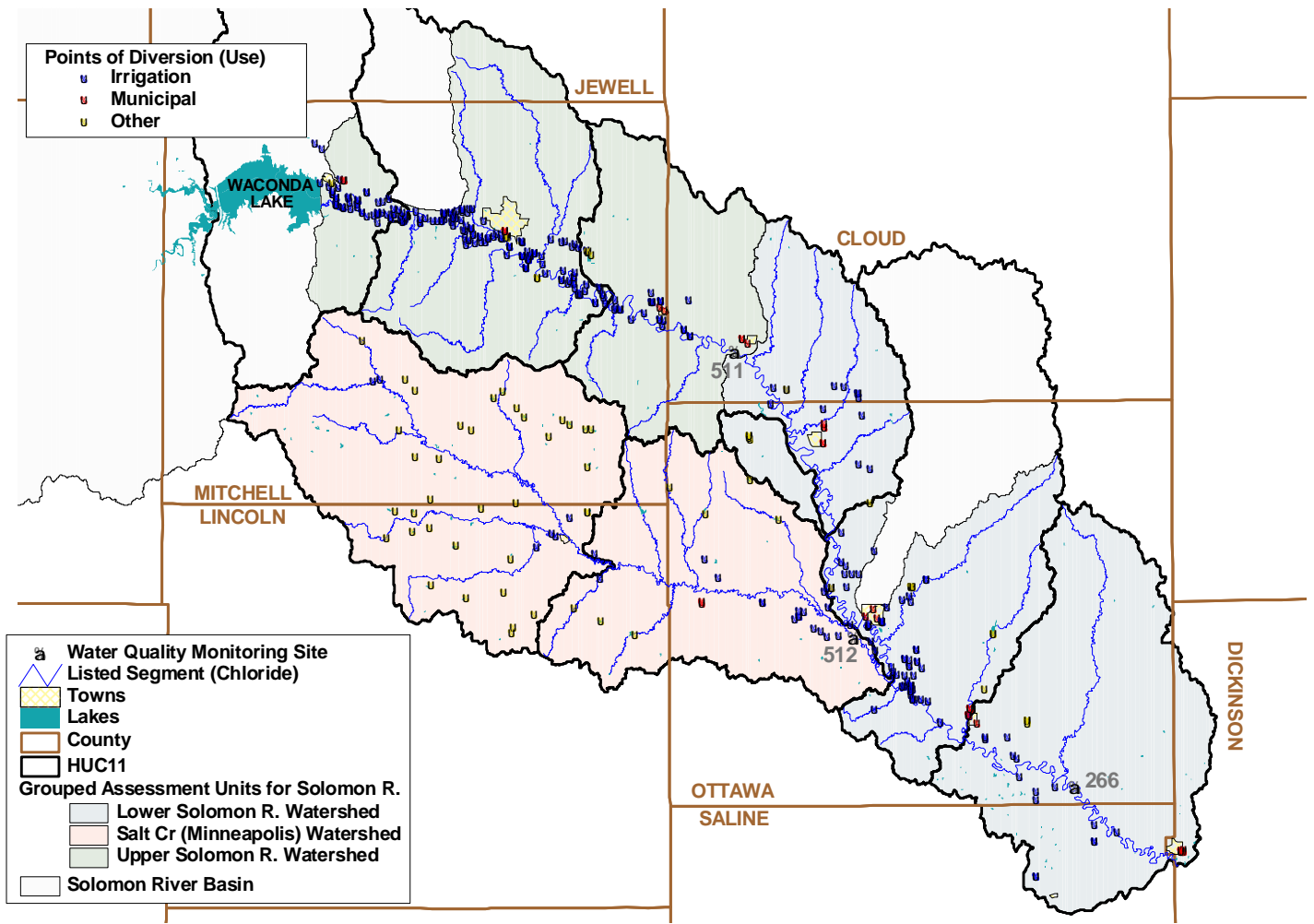
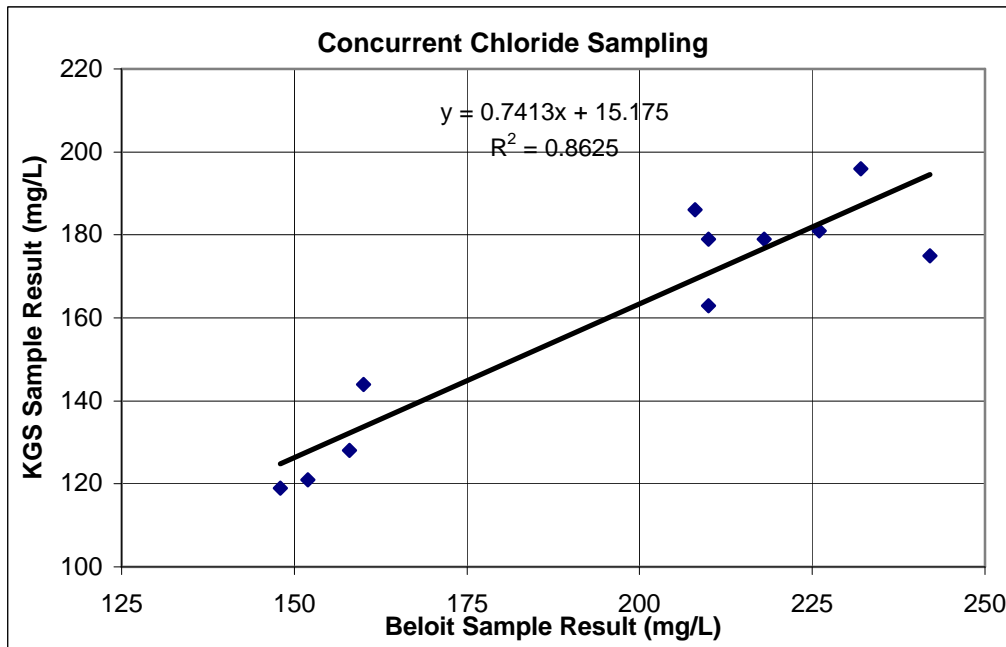


Figure 14

The KGS for Open-File Report 2003-49 found that historic USGS and KDHE data indicate that the actual conditions are rare during which the chloride concentration of the Solomon River at Beloit truly exceeds the recommended secondary drinking water limit of 250 mg/L. Comparison of chloride measurements made by the KGS for Open-File Report 2003-49 (maximum error of 3%) with City analyses made on the same day indicate that the City values averaged 22% too high during 2002-2003. (see **Figure 15** for comparison of concurrent samples collected by KGS and the City of Beloit during the study period).



**Figure 15**

To maintain chloride concentrations below the 250 mg/L target at the City of Beloit diversion point, increases in the outlet release from Waconda Lake could be used for dilution. The release rate increase is expected to be small. A complete explanation of the equation for calculating the outlet release can be found in Report 2003-49. The equation is as follows:

$$\Delta F = [1.13 \times F_{R1} (C_{B1} - C_{B2})] / (C_{B2} - C_R)$$

where

$\Delta F$  is the increase in flow released from Waconda Lake, ft<sup>3</sup>/sec,

$F_{R1}$  is the outlet flow from the lake before the added release, ft<sup>3</sup>/sec,

$C_{B1}$  is the chloride concentration of the Solomon River at Beloit before the release, mg/L,

$C_{B2}$  is the chloride concentration of the river desired at Beloit, mg/L

and  $C_R$  is the chloride concentration of the lake water (outlet flow), mg/L.

As an example, the equation predicts that an increase of 2.6 ft<sup>3</sup>/sec in the outlet flow would dilute a chloride concentration of 270 mg/L in the river at Beloit to 240 mg/L, given an existing outlet release of 10 ft<sup>3</sup>/sec and a lake chloride content of 107 mg/L. If the lake chloride content were 140 mg/L, the increase in the outlet release would be 3.4 ft<sup>3</sup>/sec instead of 2.6 ft<sup>3</sup>/sec. Assuming other variables are held constant, a smaller existing outflow would require a smaller increase in the release needed for the chloride concentration dilution.

Phreatophytes in the riparian corridor of the Salt Creek (Minneapolis), Upper Solomon River and Lower Solomon River watersheds may also have increased the chloride concentration of shallow ground waters; concomitant increases in chloride contents in the shallow ground water discharged to streams would also be expected.



## NPDES:

### Upper Solomon Watershed (Site 511)

There are two NPDES municipal permitted wastewater dischargers within the Upper Solomon watershed that would contribute a chloride load to Site 511 (**Figure 16**). These systems are outlined in **Table 4**. The city of Beloit has monthly effluent monitoring records for chloride since 2002. The average effluent chloride concentration was 247 mg/L with a range from 190 – 390 mg/L. From the same period, drinking water monitoring records and KGS data collected from the Beloit diversion point indicate the average chloride concentration during this same period was 163 mg/L with a range from 104 – 220 mg/L. The average percent increase in chloride concentration from drinking water to effluent is about 50%. This is a larger increase than expected for concentration solely related to evapotranspiration consumption of the water. Most of the increase is probably related to the discharge of waste saltwater from conventional water softener units in homes located within the City.

It is assumed that lagoon systems will have a larger evaporation component than the mechanical plant utilized by the city of Beloit and that the source water supplied to towns located in the Solomon Basin is of similar hardness requiring comparable water softening using similar levels of rock salt to recharge the cation exchange medium. Based on these assumptions, a 2:1 chloride ratio of effluent to drinking water will be used to estimate effluent chloride concentrations for municipalities that do not sample their effluent for chloride and rely on lagoon systems for treatment of their wastewater. This ratio represents the “Best Professional Judgment” as to the expected relationship between municipal source water and effluent chloride concentrations discharged from lagoon systems.

The city of Glen Elder does not monitor their effluent for chloride. The average chloride concentration of their drinking water was 127 mg/L for 1997-2003. Using the estimated ratio of drinking water to effluent, Glen Elder’s effluent should have approximately 250 mg/L chloride.

### Salt Creek (Minneapolis) Watershed (Site 512)

There are no NPDES municipal permitted wastewater dischargers within the Salt Creek (Minneapolis) watershed that would contribute a chloride load to Site 512 (**Figure 16**). The city of Barnard has a non-discharging lagoon that may contribute a chloride load to Salt Creek (Segment 29) under extreme precipitation events (stream flows associated with such events are typically exceeded only 1 - 5 % of the time). Such events would not occur at a frequency or of a duration that they would constitute a chronic impairment to the designated uses of the stream. All non-discharging lagoon systems are prohibited from discharging to the surface waters of the state. Under standard conditions of these non-discharging facility permits, when the water level of the lagoon rises to within two feet of the top of the lagoon dikes, the permit holder must notify KDHE. Steps may be taken to lower the water level of the lagoon and diminish the probability of a bypass of sewage during inclement weather. Bypasses may be allowed if there are no other alternatives and 1) it would be necessary to prevent loss of life, personal injury or severe property damage; 2) excessive stormwater inflow or infiltration would damage the facility; or 3) the permittee has notified KDHE at least seven days before the anticipated bypass. Any bypass is immediately reported to KDHE.

#### Lower Solomon Watershed (Site 266)

There are four NPDES municipal permitted wastewater dischargers within the Lower Solomon watershed that would contribute a chloride load to Site 266 (**Figure 16**). These systems are outlined in **Table 4**.

The city of Solomon also has a wastewater discharge in the Lower Solomon watershed and the city of New Cambria and KDOT have non-discharging lagoons in the Lower Solomon watershed. Each of these systems are located downstream of the watershed's monitoring site, cannot contribute a chloride load to the chloride impairment there and therefore will not be considered a chloride load source within this TMDL.

The city of Glasco has a non-discharging lagoon that may contribute a chloride load to Solomon River (Segment 12) under extreme precipitation events (stream flows associated with such events are typically exceeded only 1 - 5 % of the time). Such events would not occur at a frequency or of a duration that they would constitute a chronic impairment to the designated uses of the stream. All non-discharging lagoon systems are prohibited from discharging to the surface waters of the state. Under standard conditions of these non-discharging facility permits, when the water level of the lagoon rises to within two feet of the top of the lagoon dikes, the permit holder must notify KDHE. Steps may be taken to lower the water level of the lagoon and diminish the probability of a bypass of sewage during inclement weather. Bypasses may be allowed if there are no other alternatives and 1) it would be necessary to prevent loss of life, personal injury or severe property damage; 2) excessive stormwater inflow or infiltration would damage the facility; or 3) the permittee has notified KDHE at least seven days before the anticipated bypass. Any bypass is immediately reported to KDHE.

None of the discharging facilities in the Lower Solomon River watershed monitor for chloride. The City of Delphos rarely discharges and the City of Bennington has not shown a discharge since operation of their new lagoon facility began in 2000. The Minneapolis Power Plant operates from June 15 – September 15 annually.

**Table 4**

<b>Discharging Facility</b>	<b>NPDES Permit</b>	<b>Stream Reach</b>	<b>Segment</b>	<b>Design Flow</b>	<b>Type</b>
Glen Elder WTF	M-SO18-OO01	Limestone Cr	18	0.05 mgd	Lagoon
Beloit WTP	M-SO05-OO01	Solomon R	14	0.6 mgd	Mechanical
Delphos WTF	M-SO11-OO02	Solomon R	12	0.065 mgd	Lagoon
Minneapolis WTF	M-SO27-OO02	Lindsey Cr	7	0.234 mgd	Lagoon
Minneapolis Power Plant	I-SO27-CO02	Pipe Cr	9	0.327 mgd June 15 – Sept 15	Cooling
Bennington WTF	M-SO06-OO02	Sand Cr	4	0.088 mgd	Lagoon

The average chloride concentration of the city of Delphos drinking water was 24.5 mg/L for 1997-2003. Using the estimated ratio of drinking water to effluent, Delphos' effluent should have approximately 50 mg/L chloride. The average chloride concentration of the City of Minneapolis and Bennington drinking water were 24 mg/L and 33 mg/L, respectively. The resulting effluent chloride concentrations should be 50 mg/L and 65 mg/L, respectively. The Minneapolis Power Plant uses city water for once through, non-contact cooling purposes for peaking and emergency power. Although some evaporation of the once through cooling water is

expected, the concentration of chloride should not be much higher than the source water (24 mg/L chloride).

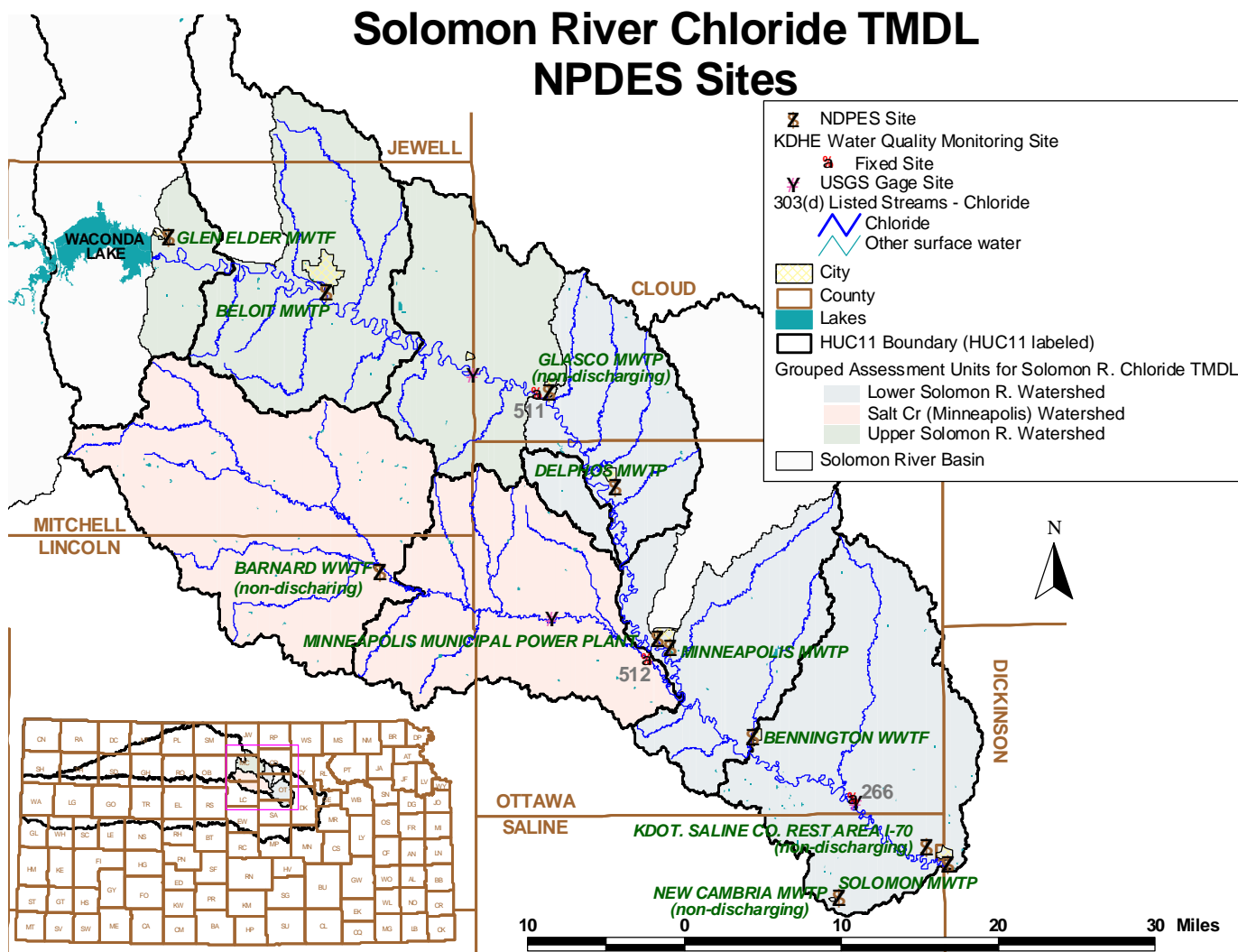


Figure 16

**Contributing Runoff:** The Solomon River downstream of Waconda Lake watershed's average soil permeability is 1.0 inches/hour according to NRCS STATSGO database. Essentially the entire watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions (99.5%). Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced to about 67%. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.57"/hr of rain will only generate runoff from 11% of this watershed, chiefly from areas along the main stem.

#### 4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

Sources of chloride that are external to the natural sources include the discharge of water containing dissolved rock salt used for water softeners and for road de-icing. Human activities can cause enhanced consumption of water through increased evapotranspiration increase the concentration of chloride from natural and anthropogenic sources. These sources and impacts are very small in comparison with the load from natural sources. The chloride concentration will continue to vary substantially from wet to dry climatic periods and in response to where precipitation falls within the drainage basin. The chloride content of the Upper Solomon River, Salt Creek and Lower Solomon River watersheds can be expected exceed 250 mg/L from natural causes during lower flows.

##### **Point Sources:**

The following Wasteload Allocations are applicable only upon initiation of the use of these surface waters for potable supply through a constructed point of diversion.

##### Site 511 (Upper Solomon Watershed)

A Phase One Wasteload Allocation of 1,357.5 lbs (0.68 tons) chloride per day will be established by this TMDL for Site 511 at the 250 mg/L standard and is based upon the design flows (Glen Elder 0.05 mgd, 104.4 lbs/day chloride; Beloit 0.6 mgd, 1,253.1 lbs/day chloride) of the point sources (**Figure 17**). Pursuant to Kansas implementation procedures for wastewater permitting, should the elevated background concentration be established at 400 mg/L, the WLA would still remain the same as the Phase One Wasteload Allocation (1,357.5 lbs or 0.68 tons per day).

##### Site 512 (Salt Creek (Minneapolis) Watershed)

Due to a lack of discharging facilities contributing a chloride load within the watershed a Phase One Wasteload Allocation (WLA) of zero is established (**Figure 18**). Any future NPDES and state permits will be conditioned such that discharges from the permitted facilities will not cause violations of applicable criteria. Non-discharging facilities will also have a WLA of zero.

##### Site 266 (Lower Solomon Watershed)

A Phase One Wasteload Allocation of 1,193 lbs (0.6 tons) chloride per day will be established by this TMDL for Site 266 at a 200 mg/L target at each point source's design flow and is based upon the estimate of the point source's current effluent chloride content and an allowance for future growth (Delphos 0.065 mgd, 108.6 lbs/day chloride; Bennington 0.088 mgd, 147 lbs/day chloride; Minneapolis 0.234 md, 391 lbs/day chloride; Minneapolis Power Plant 0.327 mgd, 546 lbs/day chloride) of these point sources (**Figure 19**). Pursuant to Kansas implementation procedures for wastewater permitting, should the elevated background concentration be established at 368 mg/L, the WLA would still remain the same as the Phase One Wasteload Allocation. Non-discharging facilities will have a WLA of zero.

Any future NPDES and state permits will be conditioned such that discharges from the permitted facilities will not cause violations of applicable. Ongoing inspections and monitoring of these systems will be made to ensure that minimal contributions have been made by these sources.

**Non-Point Sources** The elevated chloride concentrations predominately stem from background geologic sources.

#### Site 511 (Upper Solomon Watershed)

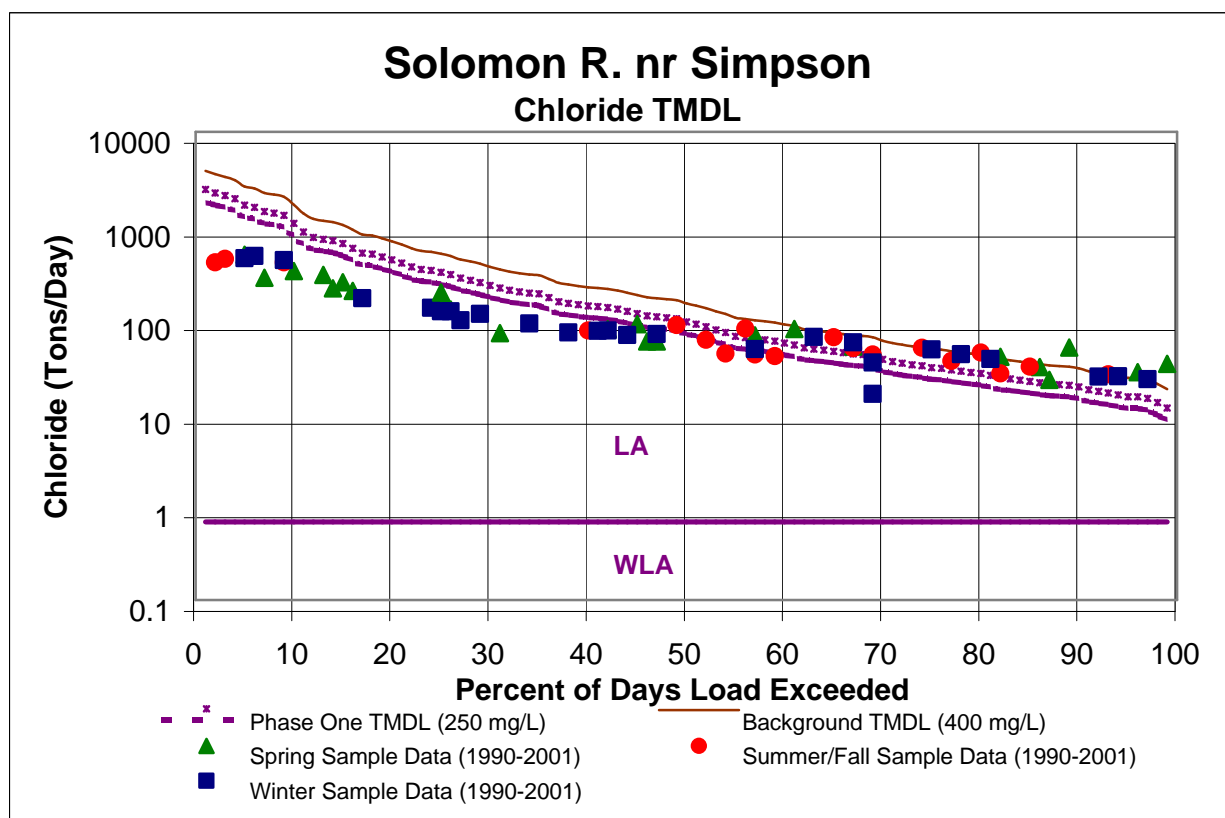
The Load Allocation is based on the existing standard of 250 mg/L for stream flows in excess of point source design flows and is shown in **Figure 17**. From this, the load allocation is 92.5 tons chloride per day at median flow (138 cfs). The LA using a background chloride concentration of 400 mg/L is 148.4 tons per day at median flow for Site 511.

#### Site 512 (Salt Creek (Minneapolis) Watershed)

The Load Allocation is based on the existing standard of 250 mg/L for all stream flow and is shown in **Figure 18**. From this, the load allocation is 10.3 tons chloride per day at median flow (15.3 cfs). The LA using a background chloride concentration of 650 mg/L is 26.85 tons per day at median flow for Site 512.

#### Site 266 (Lower Solomon Watershed)

The Load Allocation is based on the existing standard of 250 mg/L for stream flows in excess of point source design flows and is shown in **Figure 19**. From this, the load allocation is 114.15 tons chloride per day at median flow (170 cfs). The LA using a background chloride concentration of 370 mg/L is 169.2 tons per day at median flow for Site 266.



**Figure 17**

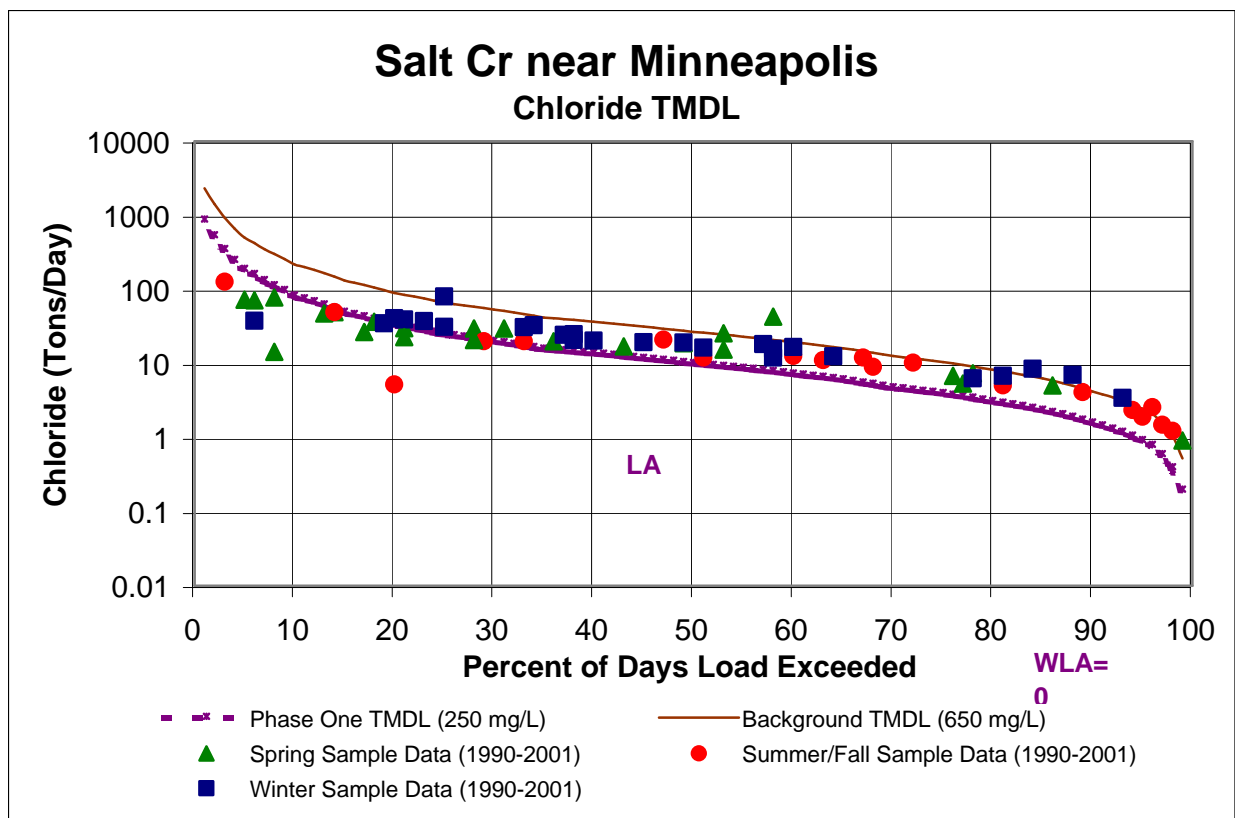


Figure 18

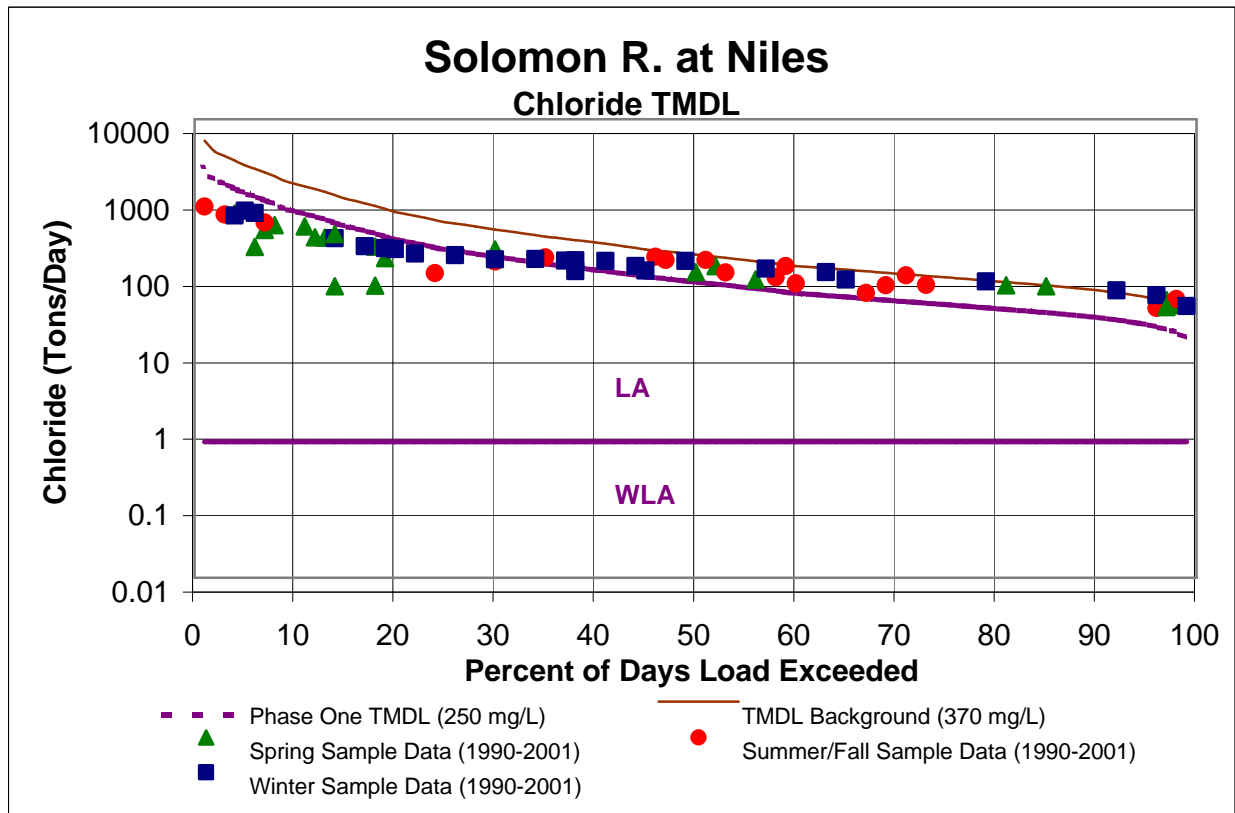


Figure 19

**Defined Margin of Safety:** The Margin of Safety provides some hedge against the uncertainty of loading and the chloride endpoints for the Salt Creek and Solomon River systems. Since the maximum chloride concentration has occurred during conditions dominated by base flows and the current background estimates are less than this critical level, the margin of safety is considered implicit in this TMDL. Furthermore, with the exception of the City of Beloit's diversion point on Segment 14 of the Solomon River, the lack of water diversion works along the river limits the applicability of the domestic water supply criterion. Holding the discharging facilities located within Upper and Lower Solomon River Watersheds to 250 mg/L and 200 mg/L chloride, respectively, provides explicit assurance that chloride loads from these source will not exceed historic levels.

**State Water Plan Implementation Priority:** Because the chloride impairment in the Salt Creek (Minneapolis), Upper Solomon and Lower Solomon watersheds is due to natural geologic sources, this TMDL will be a Low Priority for implementation.

**Unified Watershed Assessment Priority Ranking** This watershed lies within the Solomon Basin (HUC 8: 10260015) with a priority ranking of 23 (Medium Priority for restoration work).

**Priority HUC 11s and Stream Segments:** Because of the natural geologic contribution of this impairment, no priority subwatersheds or stream segments will be identified.

## **5. IMPLEMENTATION**

### **Desired Implementation Activities**

1. Monitor any anthropogenic contributions of chloride loading to river.
2. Establish alternative background criterion.
3. Support activities by the Kansas Department of Agriculture, Division of Water Resources in using Waconda Lake releases to prevent chloride concentrations from exceeding water supply criteria at the city of Beloit diversion point on the Solomon River.

### **Implementation Programs Guidance**

#### **NPDES and State Permits - KDHE**

- a. NPDES and state permits for facilities for facilities in the watershed will be renewed after 2004 with chloride monitoring and any appropriate permit limits which protects the domestic water supply criteria at any existing or emerging drinking water point of diversion on these streams.

#### **Non-Point Source Pollution Technical Assistance - KDHE**

- a. Evaluate any potential anthropogenic activities that might contribute chloride to the river as part of an overall Watershed Restoration and Protection Strategy.

#### **Water Quality Standards and Assessment - KDHE**

- a. Establish background levels of chloride for the river and tributaries.

### **Solomon River/Lake Waconda Release Program- KDA/DWR**

- a. Consult with and support efforts by the Division of Water Resources on establishing the Waconda Lake release program to minimize Solomon River chloride concentrations from exceeding drinking water criteria at the City of Beloit diversion point.

**Timeframe for Implementation:** Development of a background level-based water quality standard should be accomplished with the water quality standards revision.

**Targeted Participants:** Primary participants for implementation will be KDHE and KDA/DWR.

**Milestone for 2008:** The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Salt Creek (Minneapolis), Upper Solomon and Lower Solomon watersheds should indicate no evidence of increasing chloride levels relative to the conditions seen in 1990-2003. Should the case of impairment remain, source assessment, allocation and implementation activities will ensue.

**Delivery Agents:** The primary delivery agents for program participation will be the Kansas Department of Health and Environment and the Kansas Department of Agriculture, Division of Water Resources.

### **Reasonable Assurances:**

**Authorities:** The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.
4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.



6. The *Kansas Water Plan* and the Solomon Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

**Funding:** The State Water Plan Fund, annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration.

**Effectiveness:** Minimal control can be exerted on natural contributions to loading.

## 6. MONITORING

KDHE will continue to collect bimonthly samples at Stations 511, 512 and 266, including chloride samples, in each of the three defined seasons. Based on that sampling, the priority status will be evaluated in 2008 including application of numeric criterion based on background concentrations. Should impaired status remain, the desired endpoints under this TMDL will be refined and direct more intensive sampling will need to be conducted under specified seasonal flow conditions over the period 2008-2012.

Monitoring of chloride levels in effluent will be a condition of NPDES and state permits for facilities. This monitoring will continually assess the contributions of chloride in the wastewater effluent released to the stream.

## 7. FEEDBACK

**Public Meetings:** Public meetings to discuss TMDLs in the Solomon Basin were held October 3, 2002, January 7 and March 3, 2003 in Stockton. An active Internet Web site was established at <http://www.kdhe.state.ks.us/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Solomon Basin.

**Public Hearing:** Public Hearings on the TMDLs of the Solomon Basin were held in Stockton on June 2, 2003.

**Basin Advisory Committee:** The Solomon Advisory Committee met to discuss the TMDLs in the basin on October 2, 2002, January 6 and March 3, 2003.

**Milestone Evaluation:** In 2008, evaluation will be made as to the degree of implementation that has occurred within the watershed and current condition of Salt Creek and the Solomon River. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

**Consideration for 303(d) Delisting:** The stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

**Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process:** Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2005 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2008.